

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF DOCTOR
OF PHILOSOPHY IN MICROBIOLOGY AND BIOTECHNOLOGY

MATH 900: ADVANCED DESIGN AND ANALYSIS OF EXPERIMENTS

STREAMS: PhD

TIME: 3 HOURS

DAY/DATE: TUESDAY 13/8/2019

2.30 P.M. – 5.30 P.M.

INSTRUCTIONS:

- Answer any **THREE** questions
- Use of calculators and statistical tables is allowed
- Do not write anything on the question paper

QUESTION ONE (20 MARKS)

A researcher designed an experiment to study the growth of a particular strain of bacteria. It is suspected that the bacteria growth is influenced by temperature and environment and thus the researcher carried out the experiment at four different temperature and three levels of nutrient medium. Due to the length of time required to observe the bacteria growth, the experiment was replicated over five days with the days forming blocks

Temperature	T ₁	T ₂	T ₃	T ₄
N1	74.8	89.0	96.6	102.2
N2	78.4	99.8	109.2	112.5
N3	78.1	94.6	98.6	105.9

- (a) Giving a statistical model [3 marks]
- (b) Analyze the following results which represent totals over the five days and draw appropriate conclusions given that $TSS = 959.35$ and $SSR = 421.6$ Take $\alpha = 0.05$

[4 marks]

QUESTION TWO (20 MARKS)

(a) A researcher would like to carry out a long term experiment involving eight types of bacteria such that there are three levels of nutrient media (NM), three levels of temperatures (T) and four levels of watering plan. The researcher is not sure of the type of design to use in this experiment. Advice the researcher, clearly indicating the model and possible analysis results and why? [12 marks]

(b) The following computer output show two sets of the analysis of results from an experiment on the yields (Y) in kg/ha of cowpea planted at different row spacing (X) in cm. interpret the two outputs. [8 marks]

Model I-Response variable: Growth rate

Analysis of variance

Source	df	SS	MS	F-Value
Regression	1	249798.01	249798.01	15.628
Error	145	2269682.63	15983.68	
Total	143	2519480.64		

Estimates of regression coefficients

Variable	df	Estimate	StdError	t
Intercept	1	601.934	40.118	15.004
Temperature	1	-3.401	0.860	-3.953

Model II-Response variable: Growth rate

Analysis of variance

Source	df	SS	MS	F-Value
Regression	2	282587.347	141293.67361	8.906
Error	141	2236893.292	15864.49143	
Total	143	2519480.639		

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Estimates of regression coefficients

Variable	df	Estimate		
Intercept	1	868.68	189.80	4.577
Temperature	1	-16.205	8.95	-1.811
Growth media	1	0.14	0.0996	1.438

QUESTION THREE (20 MARKS)

An experiment with three replications was conducted to test the effect of temperature on growth of bacteria. Three different temperature regimes (20°C, 25°C and 30°C) and three bacterial types (A, B, and C) were used. The data on number of bacterial colonies are given below.

Temperature	Block	A	B	C
20°C	1	66	65	74
	2	65	65	74
	3	67	66	72
25°C	1	68	70	74
	2	69	70	75
	3	69	69	75
30°C	1	70	73	78
	2	71	73	79
	3	71	74	80

- (i) Giving a statistical model [3 marks]
- (ii) Analyze the data to test an appropriate hypothesis using a split-plot design. Take $\alpha = 0.05$ [17 marks]

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QUESTION FOUR (20 MARKS)

An experiment with three levels of growth media (M) was carried out over two seasons (Hot and cool). Carry out an analysis of variance of data combined over seasons. TSS hot = 15.73 and TSS cool = 7.37. Take $\alpha = 0.05$

Season	Replication	M ₁	M ₂	M ₃
HOT	1	4.9	6.0	6.7
	2	2.6	6.6	6.7
	3	4.5	5.7	6.8
Cool	1	5.0	6.4	6.1
	2	3.5	6.3	6.0
	3	5.4	6.6	5.9
